

Trade issues piling up for the
U.S. chemical industry Page 9
FINAL PROGRAM
ACS national meeting in Dallas Page 43

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CHEMICAL & ENGINEERING

NEWS

FOSSIL FUELS

Biotechnology applications possible
in processing, conversion
Page 28

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News of the Week

■ Illinois Supreme Court rules that Occupational Safety & Health Act of 1970 does not preempt the state from criminal prosecution of employers charged with workplace violations. **Page 6**

■ Scientists have produced an antibodylike molecule that is a good candidate for therapeutic use in AIDS patients. **Page 7**

■ DowBrands Inc., a subsidiary of Dow Chemical, has signed an agreement to purchase the European consumer products business of First Brands Corp. **Page 7**

■ The Strategic Defense Initiative seems likely to be replaced by a more limited ballistic missile defense system. **Page 8**

■ Report asks Bush Administration to loosen restrictions on export of high-technology products and scientific information. **Page 8**

News Focus

Chemical industry currently faces more than the usual number of knotty tariff reduction problems, other trade issues. **Page 9**

Business

Many venture capitalists are reluctant to invest in commercializing high-temperature superconductors because payoff is uncertain. **Page 17**

Chemical groups assess their suspension policies in light of recent suspension of Imhausen Chemie by West German association. **Page 19**

Government

NSF director Erich Bloch, now in the final year and a half of his current term, discusses current science policy issues. **Page 22**

EPA's Superfund program is criticized in three recent reports. **Page 24**

Technology

Fast-curing, stronger cement that can be poured in cold weather is developed by Lone Star Industries. **Page 37**

ICI Biological Products takes a major step toward expanding its biotechnology business. **Page 38**

ACS News

Rodney N. Hader retires as secretary and deputy executive director of ACS, ending 38-year career in various staff posts. **Page 41**

Final Program

Program for 197th ACS national meeting in Dallas includes listing of technical papers, general events, registration form. **Page 43**

Cover: Photo by Carroli Seghers/Uniphoto
Picture Agency

Letters 4

Concentrates

Business 15

Government 21

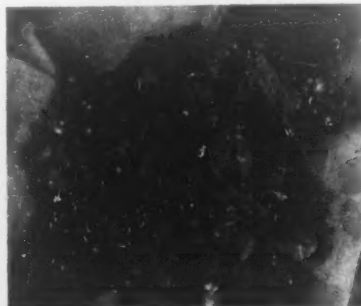
Science/Technology 27

The Departments

Books 39

New Products 119

Newsprints 150



Cover Story

Symposium explores possible applications of biotechnology in processing and conversion of fossil fuels. **Page 28**

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LETTERS

Explosives detection

SIR: With respect to the December Pan American flight 103 air disaster and the findings that it was caused by a bomb, I believe ACS (and all professional societies worldwide) should join in establishing explosives detection standards.

I remember a letter to the editor in C&EN several years ago suggesting the inclusion of a mercaptan or similar compound that could be detected easily by security dogs. I believe ACS should encourage a policy that aids in "fingerprinting" explosives. This fingerprint could be read by a dog's nose or a high-tech computer. This is a problem in which the scientific community should take an active stance.

Scott Kuhn

Houston

Peptide hydrolysis

SIR: A science concentrate (C&EN, Nov. 7, 1988, page 17) describes Clark Still's accomplishment in measuring the rate of peptide hydrolysis in pure water. In the paper describing that work [*J. Am. Chem. Soc.*, **110**, 7529 (1988)], the author comments that the simple hydrolysis of an unactivated amide has never been observed in pure water.

It should be noted that the late Jack Hine of this department reported the pH-rate profile for just such a hydrolysis reaction in his paper, "Hydrolysis of Formamide at 80 °C and pH 1-9" [*J. Org. Chem.*, **46**, 3186 (1981)], in which the water term in the rate equation was determined for the first time. The radioassay utilized in Still's group permits rates to be determined at room temperature, which was not feasible in the Hine study.

Anthony W. Czarnik

Assistant Professor
of Chemistry

Ohio State University

Labeling technology

SIR: I have been fascinated as to how rapidly our retail merchandisers have adopted bar coding to monitor inventories, receiving, sales, and so on. One can hardly go anywhere without encountering that labeling, which purportedly can be used to help reduce transcription errors, speed various tracking activities, and reduce costs in processing information on thousands of items.

Fortunately, one can go to any high-

tech chemistry laboratory to escape this labeling invasion. We are safely ensconced amid tens of thousands of reagent bottles, column materials, and supply items that are labeled as they have been for decades, so that only skilled, knowledgeable chemists can track them. Our supporting industries also have helped to protect our historical information systems and reduce the impact of this technology by mounting serial and model numbers in nonmachine readable forms usually at the rear of our instruments.

If it turns out that this labeling technology is more than a passing social fad, perhaps we, in the not too distant future, will see bar-coded labeling on our containers, catalogs, and front-mounted on our instruments. If that goes well, perhaps we will find some of our catalogs on disks with full word search capability, purchasing instructions, and dial-up features on board.

Thomas Layloff

Granite City, Ill.

Explaining reality

SIR: In reply to the question in the letter of David E. Hensie (C&EN, Sept. 26, 1988, page 73), modern science cannot answer the question, "What is reality?"

We of modern science are indebted to Galileo, 16th century physicist, mathematician, philosopher, and father of the math-experimental method we so eagerly use. The appeal of the positive proof of the method fascinated the philosophers (scientists) of his day. He cautioned them that the method was "applicable only to those areas of knowledge possessing measurable properties and inapplicable to those areas with no measurable properties such as religion, ethics, psychology, and metaphysics." Ignoring his admonition, his peers applied the method to the study of such concepts as being, existence essence, truth, cause/effect, and the reliability of sense perceptions. Chaos resulted and philosophy was divided into natural philosophy, the forerunner of modern science, and into speculative philosophy, the tool vital for the pursuit of truth.

This schism has led to the domination and application of the method of science to every domain of knowledge today whether it is applicable or not. Verification of facts and exhaustive experimentation are vital to theory and are the bases of physical science. How the resulting scientific knowledge affects or effects humanity's search for ultimate

Chemical Industry Tackles Hefty Number of Trade Issues

Tariff reductions in Uruguay round, speedier tariff cuts under U.S.-Canada free trade agreement, and unified European Community in 1992 lead list of problems facing industry policy makers

Earl V. Anderson, C&EN Northeast News Bureau

The few trade policy professionals who help shape that policy for the chemical industry constantly scan the corridors of bureaucratic Washington watching for developments in U.S. trade policy. With a two-way chemical trade that hit a hefty \$52.6 billion last year (exports of \$32.5 billion and imports of \$20.1 billion), they know that any development in the trade arena can affect most U.S. chemical companies.

These trade policy experts always have their work cut out for them. But sometimes, they have to work harder than normal, fighting tough deadline pressure and struggling with several issues simultaneously.

Now is one of those times.

For instance, the International Trade Commission (ITC) already has started to hold a series of hearings in many cities throughout the country on the probable economic effects of tariff and nontariff barrier concessions that U.S. negotiators may make in the Uruguay round of multilateral trade negotiations. The problem is, however, that many U.S. chemical companies aren't even aware that the hearings are being held. And trade policy experts in the various industry trade associations are not only trying to get the word out about the hearings, but also are trying feverishly to help some companies whip their testimony into the shape that will do the most good.

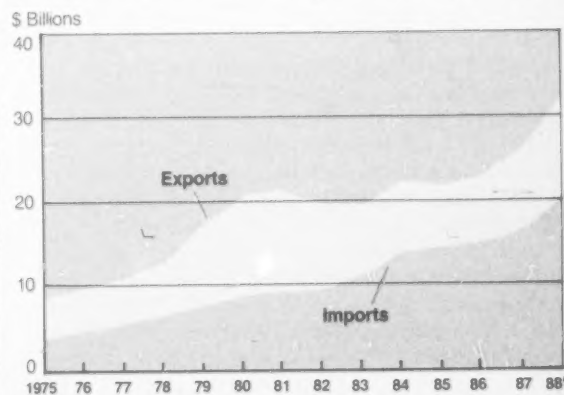
Meanwhile, just when everyone in the industry thought that they could ease up on their efforts to shape industry policy on the U.S.-Canada free trade agreement, which went into effect on Jan. 1, the U.S. Trade Representative's (USTR) office has come up with a rush request for additional input. Under the agreement, tariffs on some products are scheduled to be eliminated immediately. Others will be phased out, either by annual cuts of 20% over five years, or by annual cuts of 10% over 10 years.

However, the free trade pact allows for accelerated tariff cuts on products if both countries agree to the

speedup. USTR is looking for candidates for the speedier tariff action. But the office put its notice in the *Federal Register* a scant three weeks ago and set a tight deadline of Feb. 21 for submission. That doesn't give chemical companies—or their trade associations—much time to pull their possible candidates out of the lengthy new harmonized tariff schedules (HTSs) that the U.S. adopted, also on Jan. 1, and to muster the data needed to support their case.

Those are only two of the things that the shapers of chemical industry trade policy are trying to juggle at the same time. USTR also intends to hold hearings on the economic consequences of tariff reductions that may be made in the Uruguay round, the mammoth multilateral trade talks being held under the auspices of the General Agreement on Tariffs & Trade (GATT). The products that USTR has identified as possible grist for the tariff-cutting mill cover virtually the entire product waterfront, including 616 line items in

U.S. chemical trade surplus has widened



* C&EN estimates. Source: Bureau of the Census

the tariff schedules that relate to chemicals. Since many of those line items are so-called basket categories with from several to many products in each one of them, the number of chemicals that U.S. companies may have to evaluate is mind-boggling.

USTR hasn't announced when it will hold its own hearings on the economic impact of possible Uruguay round tariff cuts. The betting is that they will come soon after ITC finishes its hearings and submits its report to USTR.

And, as if the Uruguay round and the free trade agreement with Canada weren't enough, the chemical industry is also gearing up to tackle another thorny trade issue—the European Community's (EC) plan to create a unified EC internal market by 1992. Without minimizing the importance of GATT's Uruguay round or the U.S.-Canada free trade pact, chemical industry trade leaders emphasize that what has become known as "EC-92" is a critically important trade issue for U.S. chemical companies.

EC-92 has blossomed into the latest buzzword in trade circles. It is the subject of choice for many business meetings. For instance, the Conference Board, the New York City-based business research group, recently devoted a meeting to the subject. Other organizations, such as the U.S. Chamber of Commerce and the National Association of Manufacturers, are busy cranking out reports on EC-92. Meanwhile, the Synthetic Organic Chemical Manufacturers Association (SOCMA) and the Chemical Manufacturers Association (CMA) are canvassing their members to ferret out what chemical companies themselves may consider as stumbling blocks to success in a unified EC.

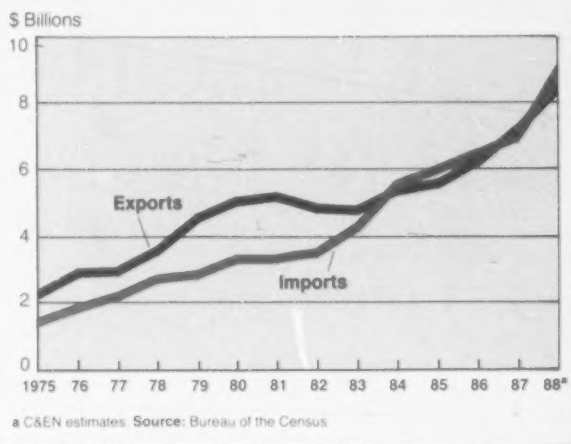
Some government agencies already have taken action relative to EC-92 and others are preparing to act. The Commerce Department has been following EC-92 progress closely, zeroing in on, among other things, EC's new approach to developing standards. Commerce has been holding briefings on EC-92 for industry trade advisers, including those from the chemical industry. Now, at the request of the House Ways & Means Committee and the Senate Finance Committee, ITC is preparing a study and will hold hearings on the impact of greater EC economic integration in April. According to John Gersic, chief of ITC's energy and chemicals division, "This one is a biggy."

Just what is EC-92? It is nothing more than another EC attempt to achieve full economic integration, which was one of the original goals of the 1957 Rome Treaty. After some early successes—a common agricultural policy, later a common fisheries policy, and a customs union with a common external tariff—progress toward complete economic integration ground to a halt.

The problem was that many EC member countries couldn't bring themselves to sacrifice any more of their national sovereignty. Now, after suffering through their economic problems of the late 1970s and early 1980s, EC countries believe that the only way that they can position themselves to compete against the U.S. and Japan in the global marketplace is to try once more for their elusive unification.

The target date for achieving this single internal

Chemical trade with European Community: U.S. imports more than it exports



market is the end of 1992. It will involve rewriting and harmonizing hundreds of individual country laws, regulations, and policies. What comes out of this effort will affect trade and investment decisions on thousands of products.

The EC effort will affect U.S. companies doing business in the community just as much as, if not more than, the European companies themselves. In the U.S., at least in some of the media, screeching about EC-92 is becoming louder and louder. Headlines warn about a "Fortress Europe" and a "protectionist entity" in 1992. Sir Roy Denman, head of the EC delegation in the U.S., says, "Anyone would think that [EC] was transforming itself into the big bad wolf of world trade in the 1990s." He, of course, doesn't think that's the case and he believes that saner business heads in the U.S. don't think so either.

Nevertheless, there's a healthy concern in the U.S. about what happens in EC's drive toward 1992. U.S. chemical companies share that concern. And for good reason. The 12 EC countries account for 26% of U.S. chemical exports and a whopping 44% of its chemical imports. Two-way chemical trade between the two trading partners last year totaled \$9.4 billion.

Generally, the U.S. chemical industry supports EC's efforts toward 1992. But, says CMA, U.S. chemical companies have to watch carefully as many of the directives needed to launch EC-92 are developed. Whereas EC-92 may provide terrific marketing opportunities for U.S. chemical companies, it also could be structured to discriminate against outsiders or to put foreign companies at a disadvantage.

U.S. chemical companies will have to examine the implications of EC-92 from two different perspectives: a U.S.-based multinational company with substantial operations in Europe and a U.S. company that exports to Europe. For European subsidiaries of U.S. chemical companies, the impact should be about the same as for their strictly European counterparts. And CMA thinks that the European-based chemical industry will come

out a winner when EC-92 is fully implemented. The expected lift to economic growth likely will boost chemical sales. And EC-92 will make it possible for European chemical companies to rationalize production and improve efficiency.

But U.S.-based chemical exporters will be able to share in the promise of a revitalized European market if they are allowed to compete on an equal footing with their European counterparts. As a result, their concerns about EC-92 parallel those of European companies, but they run deeper.

Technical standards, for instance, could be a problem. Although they are being harmonized in EC, exporters still will have to meet the standards in the country of entry. It's possible, too, that some standards may discriminate against U.S. exporters. New packaging and labeling requirements could become a problem.

Some industry trade associations, such as CMA, are asking their member companies to develop a "watch list" of potential trouble spots. They are reminding them not to overlook their European subsidiaries as a source of information. And they are keeping close tabs on developments by their connections with counterpart organizations in Europe.

So far, CMA has come up with no definitive policy statements on EC-92. But when the time comes to funnel private-sector advice into government channels, it expects to have specific recommendations.

Meanwhile, SOCMA chairman John Mack already has asked the new Bush Administration "to get America more involved in the debates" over EC-92. He doesn't want the U.S. chemical industry to wake up to a fait accompli that will endanger its export prowess. Mack recognizes that the U.S. can't tell its allies what to do. But, he says, "We can tell them what we will do in certain situations."

EC-92, however, is still three years away. A more immediate concern for chemical companies is next

week's deadline for filing their wish list of products to receive accelerated tariff cuts under the U.S.-Canada free trade agreement.

Although not in the same league as EC, Canada nevertheless is an important part of the U.S. chemical industry's trade picture. With \$3.9 billion worth of chemicals going north of the border from U.S. plants, Canada is almost as big a customer for U.S. chemicals as Japan. As a foreign chemicals supplier, it is bigger than Japan. Canada shipped \$3.8 billion worth of chemicals to the U.S. last year, second only to the combined strength of the 12 EC member countries.

In addition, the chemical industry worked as hard as any to help government trade officials shape the free trade pact. So now USTR's quick call for possible alterations to the agreement's recently arranged tariff structure is bound to pique the industry's interest.

Under the agreement, tariffs on all products traded between the two countries will be completely eliminated. Some became duty-free on Jan. 1. Tariffs on other products will be completely phased out, either over five years or 10 years. However, if one country requests it and both countries agree, tariffs on selected products can disappear faster than originally planned. For instance, the two countries may agree to reduce the staging period on some products from 10 years to five years. On others, they may agree to eliminate immediately tariffs that were to disappear over five years.

Two aspects of the accelerated tariff phaseout trouble the chemical industry. One is the tight deadline; the other is that the U.S. and Canadian governments may agree to accelerated staging on products that are not "noncontroversial."

Throughout the negotiations over the free trade pact, the U.S. chemical industry's unflinching position was that any accelerated tariff phaseouts must be



Denman (left): EC won't become big bad wolf of trade world. Turnipseed (above): lack of interest may backfire. Hill: not much time to formulate plan



noncontroversial and that the standard for determining what is and is not noncontroversial must be the same as the one Congress applies when it considers temporary duty-suspension bills.

CMA, at least, believes that candidates for accelerated tariff phaseout must originate in the private sector, not in government. The free trade pact, it says, is a balanced agreement and its tradeoffs have been carefully crafted. If the two governments agreed to controversial tariff accelerations, they would undermine the pact's "fundamental balance." CMA's basic stance is that if any company objects to a proposal for accelerated tariff cuts, the proposal should be rejected.

Despite the tight deadline, the steps that USTR has taken to seek private-sector advice sits well with the chemical industry. And, although there may be a few, it's not likely that U.S. chemical companies will submit many chemical candidates for accelerated tariff phaseout. The free trade agreement itself is very new. If such candidates had existed, they already would be part of the product category whose tariffs went to zero on Jan. 1. However, most chemicals were put into, and remain in, the five-year category.

Still, the U.S. chemical industry will be watching closely the products that Canadian chemical companies put up as candidates for accelerated tariff elimination. The Canadian chemical industry, of course, is going through the same procedure with its government that the U.S. industry is. U.S. chemical trade experts suspect that Canadian chemical companies may propose some or all of the 26 major petrochemicals that had been their candidates for free trade very early in the negotiations, when "sectoral" free trade still was being considered. If this were to happen, it would be far from noncontroversial, at least from the U.S. industry's point of view.

The tariff question, of course, goes beyond just the U.S.-Canada free trade pact. The U.S. chemical industry still has to cope with the question of possible tariff cuts in GATT's Uruguay round of multilateral trade

negotiations (MTN), which involves more than 90 member countries.

The industry's position on MTN tariff cuts has been made loud, clear, and often to U.S. trade negotiators. The message: Don't give away the store. Inevitably, GATT negotiators will include tariff reductions in the Uruguay round. But the chemical industry doesn't want them to be the focal point of the negotiations. The main thrust, it insists, should be on nontariff barriers to trade.

But if tariff cuts are to be made, say industry trade advisers, they should be made on a "request and offer" basis, that is, if one country requests that another country cuts tariffs on a particular product, the first country will respond with a specific tariff-cutting offer of its own.

As outlined by the Office of the Chemical Industry Trade Adviser (OCITA), U.S. trade negotiators definitely should not succumb to a "formula" or "across-the-board" tariff-cutting scheme. And they should propose tariff reductions only if the reciprocal offer enables U.S. companies to improve access to foreign markets.

But these are broad policy statements. Chemical companies are interested in products and what happens to tariffs on specific products. Companies now have their chance to express their views at the series of hearings that ITC currently is holding at many cities throughout the country. Five hearings should have been held by now. Two (New Orleans and Miami) were canceled because nobody expressed an interest in coming. No chemical companies signed up for the other three, either.

ITC has another 10 hearings scheduled between now and April 3 and 4, when the last hearing will be held at ITC's headquarters in Washington, D.C. So far, only one chemical company—Ethyl Corp.—has indicated that it wants to testify. It has signed up for the last hearing in Washington.

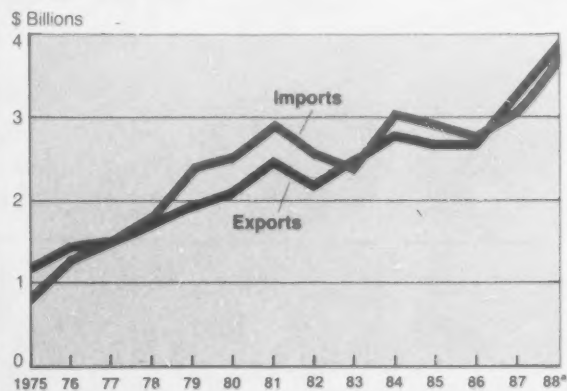
CMA also has requested a time slot at the Washington hearings. Its testimony will focus on how U.S. chemical companies may be affected by any changes in tariffs—and nontariff barriers—that may come out of the Uruguay round. However, CMA will be covering the entire chemical spectrum, which ranges from chapters 29 through 40 in the new HTSs.

It's up to individual companies to provide the necessary economic and marketing data to support its claim that a product may be import-sensitive and should be exempted from any possible tariff cuts. Clearly, companies haven't been forming long lines to sign up for the ITC hearings that will enable them to do just that.

This has CMA concerned. Max L. Turnipseed, manager of international trade affairs for Ethyl Corp. who is also serving temporarily as CMA's special trade adviser, says that this seeming lack of interest may backfire on the industry.

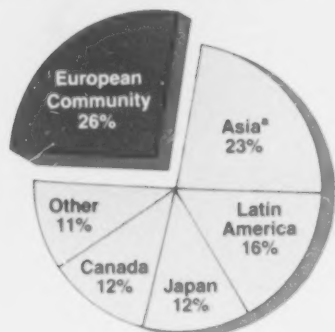
One explanation for the chemical no-shows at the ITC hearings is that chemical companies can make written submissions to ITC instead of testifying in person, and they have until April 13 to do it. That

U.S. chemical trade with Canada edges into black



* C&EN estimates. Source: Bureau of the Census

EC barely edges Asia as U.S. chemical exports market . . .



1988 U.S. chemical exports = \$32.5 billion^b

. . . but dominates U.S. chemical imports



1988 U.S. chemical imports = \$20.1 billion^b

^a Excluding Japan but including communist Asia ^b C&EN estimates. Source: Bureau of the Census

gives companies more time to prepare their data. And it avoids the time and expense of sending their top management to give testimony at a hearing.

Officially, written submissions carry the same weight with ITC and other government trade agencies as oral testimony. However, human nature has a way of creating a bias against no-shows. Of course, no one will say for the record that this is what happens. But those familiar with the workings of official Washington know that it does.

That is why CMA is urging its members to start planning their appearances at the ITC hearings, says Turnipseed. Meanwhile, CMA international experts, along with their counterparts at SOCMA, are surveying their members to see what products they consider to be "import sensitive" and should be exempted from Uruguay round tariff cuts. They also are asking chemical companies to identify products upon which they would like to have other countries make tariff concessions.

So far, the emphasis has been on the import sensitive items. CMA started out by sending its members a list of products—about 300 line items in the HTS—that had been considered import sensitive in the previous two GATT rounds of multilateral trade talks (the Kennedy round and the Tokyo round). The replies, along with those from SOCMA members, will be distilled and a new list sent back out for final member review.

This list probably will contain about 120 HTS line items. Based on preliminary work, it's likely that most of the products that chemical companies will consider to be import sensitive will fall in chapter 29 (organic chemicals), although chapters 32 (dyes) and 28 (inorganics) will have more than their share of candidates.

The "turnaround" time for this final review, says Turnipseed, will be fast. It will have to be, because the combined results of the CMA and SOCMA surveys probably will become the basis for OCITA's testimony

at the ITC hearings in Washington in April.

But neither CMA nor OCITA can do the job that individual chemical companies can at the ITC hearings, or at the subsequent hearings that will be held by USTR. "It's not enough to just say that a product is import sensitive," says Turnipseed. "You have to back up the words with sound economic and marketing data." And only the companies, he says, can provide that data.

ITC staffers will have to condense all the information they receive from their hearings and written submissions into a report for USTR. In addition, USTR's trade policy staff committee will hold its own hearings, with every article in the tariff schedules up for grabs.

USTR's hearings probably will start soon after ITC's end. They will have to, because Carla Hills, the new U.S. Trade Representative, and her Uruguay round crew won't have much time to formulate their battle plan for the actual negotiations on tariff cuts. At the midterm GATT meeting held in Montreal in December to assess progress in the Uruguay round (C&EN, Jan. 9, page 17), GATT ministers agreed to start "substantive" negotiations on tariffs no later than July 1, 1989. Before that, countries must exchange tariff and trade data and establish detailed negotiating procedures.

At the Montreal meeting, GATT ministers also set a target for overall tariff reductions in the Uruguay round "at least as ambitious as that achieved in the Tokyo round." Tariff cuts in the Tokyo round averaged 30 to 35%.

Although the Montreal meeting produced important agreements in 11 of the 15 Uruguay round negotiating groups, including tariffs, these agreements were put on hold until April so that negotiators could try to reach a consensus in all 15 negotiating areas. The four stumbling blocks are agriculture, safeguards (temporary import restrictions), textiles, and intellectual property rights. By far, the most important—and perhaps the most difficult—to resolve is agriculture, with intellectual property not far behind.

There's a chance that one or more of the 11 agreements already reached could disintegrate before April. And there's also little doubt that there can be no success in any area without success in agriculture and intellectual property. But if GATT history has taught the U.S. chemical industry anything, it is that trade negotiators seem to be able to agree on a package of tariff cuts, even when they can't agree on anything else.

That's why, as far as tariffs are concerned, the industry's trade policy leaders want U.S. chemical companies to give government officials their best shot whenever and wherever they get the chance. □

Venture Capitalists Cautious About High-Temperature Superconductors

Many see eventual payback as too far off and uncertain and consider it premature to invest in field still in research, instead of development, phase

Ann M. Thayer,
C&EN Northeast News Bureau

While scientists continue to ask questions about superconductivity that begin with what, how, and why, entrepreneurs and venture capitalists are starting to ask "How much?" and "How soon?" And, although it's been only two years since the discovery of high-temperature superconductors, questions like these are already forming the center of discussions about the commercialization of applications.

At a recent conference in San Francisco sponsored by the Superconductor Applications Association, nearly half the sessions were devoted to discussions on superconductor manufacturing and applications, markets, and venture capital for startup companies.

Despite apparent enthusiasm for high-temperature superconductors, it is generally expected to take from five to 15 years, and maybe longer, for commercial products to be realized from superconducting materials. These estimates are based on analyses of the state of technology and analogies with other high-technology industries such as semiconductors, computers, and biotechnology. From these models, developing technologies are expected to grow along predictable, evolutionary paths from initial discovery through R&D to applications. Although the superconductor development path is generally perceived

to be the same, some analysts are more optimistic about its rate of evolution because of a high level of excitement and interest in the field.

At least two generations of high-temperature superconductor companies are emerging—companies that have dealt in existing low-temperature superconductor applications and are now exploring high-temperature superconductors, and new ventures that have been created specifically to exploit the newer high-temperature materials. The latter case was portrayed in the results of a recent study—"What do venture capitalists think about superconductivity?"—presented at the conference by a panel from Coopers & Lybrand, an accounting and management consulting firm. Based on interviews with nearly 100 of the most active venture capitalists, the study provides an interesting perspective on commercializing superconductivity through small startup companies: Although most venture capitalists seem to find superconductivity an exciting technical frontier, very few have actually invested.

Venture capitalists look for high returns on their investment (at least 10 times), usually within a period of five to seven years. With the outlook for commercializing high-temperature superconductors further off than that, many venture capitalists are unwilling to invest in such long-term projects. Robert H. Stavers of Coopers & Lybrand indicates that the majority of venture capitalists sees the eventual payback as too far off and uncertain, and considers it premature to invest in a field still in the research, rather than development, stage. Many have taken the time to review business plans but find them lacking in a product/market focus.

A sizable minority, about 27%,



Stavers: tremendous opportunity

says Stavers, is very optimistic, seeing superconductivity as a tremendous opportunity for investment. Of this 27%, only 15 "pioneer" venture capitalists, with strong beliefs in the technology and strong stomachs to face long-term, high-risk investments, actually have invested. Not unexpectedly, the study shows, these venture capitalists previously had experience in investments of this type. The pioneer investors interviewed have funded a total of seven ventures in which, by pooling their money, they were able to reduce the risk to individuals. The average, first-round investment was \$3.2 million per venture, explains Stavers, which is not high relative to other ventures such as semiconductor companies, which averaged about \$4.9 million per venture in seed capital.

The desire to obtain an early position has caused some companies

to spring up even before a business plan, product design, or management team has been coordinated. In doing so, venture capitalists acted quickly to attract top scientists and gain patent or technology transfer rights from major universities and research centers. American Superconductor Corp. of Cambridge, Mass., which has associations with Massachusetts Institute of Technology, and Conductus Inc. of Palo Alto, Calif., which was established with a group from Stanford University and the University of California, Berkeley, are examples. As often happens under these circumstances, a member of the venture capital group will direct the company until the staff is assembled. John Shoch of Asset Management Co., the lead venture capital firm behind the funding of Conductus, initially acted as its president.

Shoch, along with many other venture capitalists, sees similarities between superconductor and biotechnology startup companies, most basically the presence of a dramatic new technology coupled with strong science advisers and strong, experienced investors. He suggests that small companies can be, and have been, the appropriate place for the development of certain technologies. Small companies have the focus, incentive to succeed, and agility to respond quickly to new developments—features that will be necessities in the rapidly changing field of high-temperature superconductors.

Because of the limited number of venture capitalists willing to invest in high-temperature superconductors, the formation of venture capital-backed companies now appears to be slowing down, indicates Shoch. Some of the largest venture capital firms may also choose to stop investing if they decide that they already have succeeded in recruiting the top scientists and wish to concentrate their efforts internally on existing companies. In addition, venture capitalists are expected to avoid past mistakes, when budding industries were flooded with too many new companies. The new companies also are starting to develop substantial corporate backing, says Shoch. For example, Hewlett-Packard Co. has a cooperative research agreement

with Conductus and has taken a 15% equity investment in the superconductor company's second round of funding.

Only a few major corporations, such as AT&T, IBM, and Du Pont, have significant R&D efforts in high-temperature superconductors, and small companies are looking to corporations as partners rather than competitors. Alliances with large companies are expected to attract further venture capital and possibly government contracts. Hal Hurwitz of Coopers & Lybrand suggests that unlike venture capitalists, whose primary goal is return on investment, corporations can be motivated to invest because of their interest in new product developments and potential technological and manufacturing improvements, in addition to financial goals.

The capital needed to continue funding product development in the new superconductor companies is estimated to be on the order of \$6 million to \$9 million per venture. In addition to corporate capital, money might be available from remaining holdouts in the group of venture capitalists that gave rise to the pioneer investors. An even larger pool of venture capitalists, who appear interested but have hesitated to invest, might be looked to for second-round financing when the technology has advanced and there is less risk, but smaller returns.

Most early investors seem to expect that prototype products can be manufactured in two to five years, with eventual returns to be on a "grand-slam" scale, commensurate with the risk involved, of 50 to 100 times the original investment. Whereas extensive commercialization may be far in the future, observers predict that small-scale electronics applications, probably with correspondingly small commercial impact, will soon appear in niche markets. For example, John H. Vanston, president of the consulting firm Technology Futures Inc., Austin, Tex., says that firm has identified more than 100 applications for superconducting materials, one quarter of which could be available in the next three years. Vanston also suggests that the driving force behind these early developments is

based not so much on the temperature profile of the materials, but rather on their electronic properties.

Sheridan Tatsuno, program manager of Dun & Bradstreet's Dataquest, analyzes high-technology markets. Whereas some observers are making guesses of hundreds of millions to a billion dollars for the size of potential markets in the next decade, Tatsuno hesitates to do this since the markets are just that—potential. "It takes about seven to 10 years for a technology to start gaining acceptance and a market, and about 15 years for it to really pick up," he says. "Right now there is nothing on which to base a guess since the market for high-temperature superconductors is zero." He believes, though, that small-scale electronics applications will appear in the market on a limited basis by 1991 or 1992 and expects these to come primarily from Japanese companies. This is because, he says, "it is the Japanese who will go for extremely simple devices first, whereas the U.S. traditionally looks to design more sophisticated, more difficult-to-produce applications."

Possible applications in the short term include items such as superconducting quantum interference devices (SQUID), sensors (magnetic, infrared, and microwave), switches, optical devices, and interconnects. Most of these devices are based on thin-film technologies, which are the most rapidly progressing area of superconducting materials processing. By taking advantage of the high-frequency characteristics of such materials, Conductus plans

Few venture capitalists invest in superconductivity



Total = 98 venture capitalists

Source: Coopers & Lybrand

to manufacture superconducting thin films for electronics applications.

Products based on bulk materials, such as wires and cables, will take much longer to develop because of the numerous limitations in the properties and processing of high-temperature superconducting materials. However, the goal of American Superconductor Corp. is to produce superconducting wires in the near future. The company has obtained rights to Argonne National Laboratory's wire technology (C&EN, Oct. 17, 1988, page 5) and a license for a wire manufacturing process recently patented by MIT (C&EN, Dec. 5, 1988, page 5). Interference with the patent is expected from the Japanese, who have submitted patents on similar processes.

Investors are particularly concerned about patent issues—the overall distribution and types of patents and how commercialization and competition in superconductor markets will be affected. Currently, the University of Houston, University of Alabama, University of Tokyo, IBM, AT&T, and Naval Research Laboratory are in competition for the patent on the yttrium-barium-copper oxide superconductor (1-2-3 material) in what looks to be a complicated dispute. However, a frequently expressed opinion is that it is very unlikely that a single patent stranglehold on the technology will come about or that patents on the materials themselves will be of overriding importance. Instead, it is expected that high-temperature superconductor commercialization will involve a variety of patents covering materials, processing, and products, and that there will be a great deal of cross-licensing of these patented technologies. To many, the most crucial concerns are centered around patents in international markets, and specifically, the role played by the Japanese.

The Japanese have been filing patents aggressively, with an estimated 2000 applications in Japan and nearly 25% of the 700 applications filed in the U.S. Of all patent applications filed in the U.S., about a third are foreign, and 10 to 15% may be put on the "patent fast track" implemented by former President Reagan.

Chemical associations eye suspension policies

For any trade association, contemplating suspension of a member company is a serious matter. Recently, the West German Chemical Industry Association (Verband der Chemischen Industrie, VCI) suspended Imhausen Chemie, the company charged with supplying a chemical weapons plant in Libya (C&EN, Feb. 6, page 4).

According to Helmut Sihler, president and chief executive officer of VCI member company Henkel Corp. and current president of the association, the action against Imhausen Chemie was taken for several reasons. One reason was to lessen possible adverse consequences—including negative public opinion and possible tighter legislation or regulation—that could affect the chemical industry and the science of chemistry.

Another major reason was "verband hygiene." In effect, Sihler said, the association could not allow the impression that it condoned such actions if they appeared to have taken place.

VCI had tried talking with Imhausen Chemie, a maker of fine chemical intermediates for pharmaceuticals and agrochemicals, Sihler said, but he noted that the company had given the association only vague, unsatisfactory answers. Sihler

did not specify what these answers were. The association then felt compelled to suspend the company, which had—as with many West German companies—been affiliated with VCI since it was formed shortly after World War II.

Thus far, few if any other chemical industry associations have had to consider taking similar action. However, for many reasons these days, they are now beginning at least to think about the possibility.

For example, on a different issue, the Chemical Manufacturers Association, in Washington, D.C., has written into its bylaws special provisions for suspension or expulsion, to accompany its new "Responsible Care" program, launched last year. Covering health, safety, and environmental quality, the program aims to improve the performance of the industry by developing management codes based on the best practices throughout the industry, explains Jon C. Holtzman, vice president of communications for CMA.

Under the bylaw provisions, he says, companies must agree to participate in the program for membership in CMA. They agree to act in good faith to implement what is needed to abide by the codes of the program. "Should a company sign on and then be so cynical as not to do anything, we would talk with them," he says. "If there was then no change on their part, we would disassociate with them."

The process would follow established lines: It would take a two thirds vote of the board of directors to lead to a suspension or expulsion because a member broke the bylaws or engaged in conduct prejudicial to the association—conduct contrary to the safe manufacture of chemicals and to acting in the public interest. "Our bylaws would not only permit us, but would require us to look at these things," Holtzman says.

One difficulty is that membership in an industry organization is voluntary. Points out John Cox, director general of the Chemical Industries Association (CIA), in London, the U.K. counterpart to CMA and VCI, "There is no obligation on chemical companies to become members. The association takes steps to encourage more companies to take up



Sihler: possible adverse consequences